

FURTHER NOTES ON MACROTRACHELOUS CALLIDINÆ.

BY DAVID BRYCE.

(Read September 21st, 1894.)

PLATES XXIII. AND XXIV.

This third paper on this group of Callidinæ has for its principal object the description of 10 species not referred to in my earlier notices.

Since I read to the Society the second of these, there has been added to the rapidly swelling list of Rotifer literature a very important contribution by Dr. Janson,⁴ dealing exclusively with the Ehrenbergian family, Philodinæa, that is to say, with the genera included in Hudson and Gosse's sub-order Bdelloida. I do not propose here to fully enumerate the contents of this treatise, a copy of which the author very courteously presented to our library, and to which each of us has, therefore, convenient access, but merely to point out to our members, in general and appreciative terms, the scope and usefulness of the work, which is admirably planned, and presents to us in a very compact form a mass of information upon the genera included. It was high time that such a monograph should be put forward, more especially as regards the genera Callidina and Adineta, which have received so many additions in these recent years. In all 52 species are admitted as valid, of which Rotifer has 13 (including two species previously known under the generic name Actinurus), Philodina 8, Callidina 25, Discopus 1, and Adineta 5. In addition to the specific characters of each of these forms, Dr. Janson provides a general key for their identification, which will to some extent facilitate this puzzling task. There is also a bibliography in continuation of those published by Dr. Zelinka in 1886 and 1888, and carried up to September, 1892. My descriptions of *Call. pusilla*, *Call. cornigera*, and *Adineta clauda* were not put forward until after that date, and consequently these species are not among the 52 species admitted, and have to be added, as are

also the five new forms to be presently described, and one old form, not admitted by Janson, but for which I furnish a new description. It may be useful to note that among the forms rejected as not sufficiently described are two of the Callidinæ described by Gosse, viz., *bihamata* and *pigra*.

As to certain matters I have arrived at conclusions differing from those of Dr. Janson. Of these only one shall be here referred to, viz., the asserted presence of pellets of food in the stomachs of certain species of Callidinæ. He so distinctly implies a repeated error on my part with regard to these pellets that I am compelled to go into the question more fully than I had previously thought needful. In describing the stomach walls of a typical Philodine, he says (p. 9):—"The lumen proper is enclosed in a strong cuticle, whose inner side is clothed with cilia; then follows the syncytial real wall, which absorbs the nutrient matter, and is usually coloured brownish or golden from fatty particles, has distributed in its substance numerous nuclei, and is surrounded externally by a thin membrane. A digestive function was until lately assigned to the pigment enclosed" (*i.e.*, to the coloured fatty particles), "Milne and Bryce regarded them as in many species portions of food, whilst Thompson⁸ rightly recognized them as fat particles lying within the stomach wall." In another place (p. 66), referring to my description of *Call. lata*, he states that, according to me, "the fat particles of the stomach are particularly large and conspicuous."

Dr. Janson has misunderstood the statements made by Milne⁵ and by myself if he thought that in our descriptions of food pellets *in* the stomach either of us referred to the well-known fatty particles enclosed in the stomach-wall itself. With *Call. constricta*, however, it is no difficult matter to demonstrate the presence of food pellets in the stomach. The œsophagus lies rather on the ventral side of the mastax, and the pellet-making is, therefore, best seen in ventral view, and to secure this a few of the Rotifers should be placed with a very little water on the cover of the live box. After a few minutes they will probably have taken hold of the glass, and have recommenced feeding. A very little carmine may then be placed on the opposite glass of the live box, and the body thereof gently adjusted to the cover. It will now be possible if the Rotifers continue feeding, as *constricta* probably will, to see the carmine particles pass down the long

gullet and between the rami into the œsophagus. It will be seen that there they are retained until a quantity has been collected, that then takes place a constriction of the œsophagus, commencing at the upper part, and that the contents are thereby forced downwards and into the stomach cavity, where they appear as a new pellet, while the œsophagus begins to collect fresh material. As soon as a pellet or two has been completed the making of more coloured pellets can be stopped by changing the water, after which the passage through the stomach of the coloured pellets already made can easily be watched.

It is scarcely necessary for me to add that I adhere to every point of my previous references to these pellet-making forms, including *Call. lata*.

I have now to explain sundry terms employed in my descriptions for the better distinction of the various divisions and parts of the body of a typical Callidina, terms which, however, apply equally well in most cases to the other Bdelloida. The term Body is used only to denote the entire animal, and includes, therefore, the three divisions—1. Head and neck; 2. Trunk; and 3. Foot. These in turn are composed of the so-called segments, the head and neck having six; the trunk six; and the foot (usually) four; in all 16.

The segments of the Head and Neck comprise the first and second Rostral, the Oral, the first, second, and third Cervical. The two rostral form the Rostrum (the anterior extremity of the body when extended), whose tip is partly invertile, and bears numerous tactile and motile cilia, shielded by the Rostral Lamellæ, two overlapping membranous plates, curiously arched. The non-invertile exterior of the tip is the Rostral Sheath. The second rostral is simply a broader base for the first.

Following them is the oral segment, distinguished by the presence of the mouth and of the ciliated discs, conspicuous even when infolded. When the mouth is opened, and the ciliated discs on their pedicels are pushed forth, these, together with the ciliated surfaces of the secondary wreath, are spoken of as the Corona. The unciliated surface now visible, in direct dorsal view, between the pedicels (and in some cases partly behind them), is the Upper Lip, which, widening as it recedes from the front, merges gradually at the sides into the Collar, that wider part immediately succeeding the bases of the pedicels. The Lower Lip is the ventral margin

of the mouth opening (now conspicuous on the ventral side of the corona). The first cervical segment carries the antenna, the second contains the greater part of the brain, and the third is usually occupied by the mastax. These six segments are retractile within those of the trunk.

The Trunk comprises those segments whose cuticle forms the exterior covering of the Callidina when most retracted. These are the first, second, third, and fourth Central, the Pre-anal, and the Anal. The second, third, and fourth central have the appearance of one large segment, the limits of the third being almost obliterated, and only indicated by slight undulations of the contour and of the longitudinal skinfolds. The greatest width of the body is usually attained in the third central, which, with the other central segments, affords room for the stomach and the two ovaries. A strong constriction separates the fourth central from the two following segments. The pre-anal is generally of considerable bulk; it contains the intestine, and gradually narrows into the smaller anal, which includes the contractile cloaca and the anus.

The Foot comprises normally four segments, the first, second, and third Joints, and the Terminal Joint, and is retractile within the trunk. The third joint bears the spurs, and is the last segment usually visible. In the act of taking fresh hold with the foot the terminal joint is quickly and momentarily protruded from the ventral portion of the third joint, and, being directed forwards and not backwards, escapes all but the keenest observation. It carries three or four toes, or in some species these are replaced by a perforate disc, used like them in the affixment of the foot.

Of these 16 segments it is often difficult to define the first rostral from the second, and the pre-anal from the anal. Frequently also the appearance of four cervical segments is equally confusing.

The food entering at the mouth is conducted by a long ciliated Gullet into the cavity of the mastax, and, passing between the rami, enters the Œsophagus, and is thence forced into the Stomach, whose length is slowly traversed. It is then projected into the Intestine, thence into the Contractile Cloaca (see under *Call. russeola*), and is finally expelled through the Anus.

The two ovaries are now demonstrated to consist each of two parts—a large Yolk-mass with eight (more or less) large bright nuclei, and a small Germ-mass placed upon the inner side of the Yolk-mass, and containing some 4 to 12 minute nuclei.

The body-length is measured from the tip of the rostrum to the tips of the spurs, when the *Callidina* is extended, as in crawling. The width of the corona is taken across the two discs, of the collar across the widest part immediately succeeding the bases of the pedicles, of the neck at the narrowest point between the collar and the first central, all in direct dorsal view, while the *Callidina* is feeding.

For greater accuracy and for convenience of comparison the dimensions are calculated and stated in microns (1000 microns = 1 mm.), and to avoid repetition of the symbol the figures are simply placed within brackets. Thus (262) is to be understood as 262 microns = 262 μ m. The small numbers following authors' names refer to appended list of authorities.

All the 10 species now to be described belong to that numerous group which I have distinguished by the term *Macrotrachelous*, as indicating their common characteristic of a relatively short foot. The first five species have not, I believe, been hitherto recorded for the United Kingdom, and inasmuch as there does not exist, as far as I can learn, any description in our language of any one of them, I have thought it desirable to reproduce more or less closely the original descriptions of the respective writers. The remaining five species are new to science.

Callidina tetraodon, Ehr.

Sp. Ch. — Body yellowish-white, only moderately transparent. Rostral lamellæ somewhat laterally projecting; spurs (11 to 15) slightly longer than width of segment carrying them, and seated upon cushion-like swellings. Rami (30 to 32), formula $\frac{4}{4}$. Maximum length (620).

Janson ⁴ gives these characters for a form assigned by him to the above species, which was defined by Ehrenberg ¹ in 1848 with the very scanty description of:—Body hyaline, eggs white, four larger teeth central on each ramus, length $\frac{1}{3}$ line.

The following supplementary details are added by Janson:—Body of 15 segments, with, dorsally and ventrally, eight longitudinal skinfolds. Hypodermis stout, milky white, slightly opaque; alimentary tract usually pale yellow. Foot very short, of three segments in all. The corona, seldom to be seen unfolded, is moderately large, and only a little exceeds the neck in width. Upper lip notched. Head, with two fronto-lateral prominences, as

in *Call. longirostris*, but less developed. The rami have very strong comb-like outer margins, usually of a dark golden or brown colour, and a fifth tooth is sometimes faintly indicated. Median ventral salivary gland conspicuously large. Yolk-mass with 8 to 12 nuclei, the germ-mass with 11 minute nuclei. Four massive foot-glands, built up of very large cells, extend, alongside the intestine, far into the body cavity. They unite and send many fine strands to the disc terminating the last tube-like foot segment. This disc, apparently formed from two toes (and having in direct view the outline of an oval pinched in laterally), has eight perforations, through which discharge the canaliculi proceeding from the foot-glands, and an extremely delicate flickering (as of cilia) was noticed at the extreme end of the disc. Antenna short and two-jointed. The excretory system has six vibratile tags (on each side). The brain is posteriorly three-lobed. Janson further describes (what he regards as) the winter or resting-egg of this species as having its surface covered with short, sharp spines, whose points are directed towards the two poles of the egg.

A form which I have found in moss from widely separated localities is, I have little doubt, that described by Janson. The most important difference is the structure of the upper lip, a character which Janson does not appear to value so highly as I do. In my examples the two lobes of the upper lip were rather prominent, and were separated by a conspicuous U-shaped sulcus, whereas he has drawn them as almost contiguous, divided only by a narrow notch. None which I have yet measured have exceeded in length 443 microns. In one measuring (427) when extended the extreme length of the corona when feeding was (87), of the collar (67), while the narrowest neck dimension was (48). This proportion of corona to neck is at first sight widely different from that indicated by Janson, but it is probable that his comparison is based upon the greatest width of the neck. In my view this latter method of comparison is rather unreliable, though certainly preferable to a comparison of the corona with the body-width, which Janson very properly condemns as fallacious. I prefer to compare, firstly, the corona-width with the collar-width and the narrowest neck-width; and, secondly, the corona-width with the length of the individual specimen, when extended as in crawling.

The species is easily distinguished from all other Callidinæ by the peculiar swollen bases or cushions upon which are seated the

moderately-curved and tapering spurs. Besides this mark are equally distinctive the prominent lobes of the upper lip, and the tooth formula, while the modification of the toes into a tube-like process, ending in a perforated disc, occurs only in a few other forms. It is probably of very general distribution in this country, as I have already seen examples from Devon, Bucks, Essex, and Sussex. I have observed in some specimens that the body fluid contained numbers of minute granular bodies which flowed hither and thither with each movement of the skin or organs. Dr. Zelinka⁸ has already observed similar constituents of the body fluid in *Call. russeola*, and says that they are doubtless the same structures which Leydig in his time described as blood-corpuscles, and which we likewise have to regard as such.

Callidina alpium, Ehr.² (Pl. XXIII., Fig. 1.)

Sp. Ch.—Stout, transparent; skin rough and stippled, but not viscid; 14 dorsal and lateral longitudinal, and 9-10 ventral transverse skin-folds; anterior margin of first central segment, with six knob-like prominences in two series, which produce a cleft appearance at anterior end when body contracted. Head with fronto-lateral swellings; corona (54), sulcus (16) wide by (10) deep; upper lip concave, (usually) with minute tooth-like prominences. Mastax longer than broad, rami ($28\frac{1}{2}$), formula $\frac{2}{2}$, teeth slightly diverging towards inner edge of ramus. Foot moderately short, of four joints; spurs (4-5), short blunt cones, with moderate interstice; toes four, in two dissimilar pairs. Max. length (238).

Habitat: Wall and ground moss, Bognor; roof moss, very abundant, Deal.

On page 11 of the "Supplement" Dr. Hudson,³ referring to Ehrenberg's species (under the name "alpina"), states that it is an alpine species of which he could find no details. Thanks, however, to the comprehensive Bibliography furnished by Zelinka, I have been able to find the original description, a very brief one, which I quote:—"Corpore hyalino, in contractione dorso longitudinaliter, ventre transverse plicato, ovulis albis, dentibus binis eccentricis. Longit. $\frac{1}{3}$ ". *E. montis Rosæ alpium*, 11138 pedum altitudine. Plicæ longitudinales 14, transversæ 9-10 valde singulares." This description was published in 1853, and the species was thereafter, like most of the other Ehrenbergian Cal-

lidinæ, lost sight of until recent years. In 1891 Zelinka⁹ mentions that he had met with it, and remarks that it is not exclusively alpine. More lately Janson⁴ (p. 29), commenting upon the insufficiency of Ehrenberg's descriptions of Callidinæ, quotes that of *C. alpium*, and declares that "if we omit the 'ventre transverse plicato,' which apparently is in this sense incorrect, and occurs in no Callidina, this description fits all the hitherto described Callidinæ with two teeth, and these are nine in number. "It is clear," he proceeds, "that a description thus common is worth none at all. *Call. alpium* has, therefore, been found by no later observer, and since Ehrenberg not again described." Janson has obviously overlooked Zelinka's identification of the species, but apart from this, he is mistaken in assuming that the character of ventral transverse folds, so emphasized by Ehrenberg, is incorrect. I have found it in two species, one of which, however, differs from the other characters given by Ehrenberg in having a tooth formula $\frac{5}{6}$, and in not being transparent. The other form, however, is fairly so, and has the tooth formula $\frac{2}{2}$. In it the transverse ventral folds are conspicuous both when the animal is contracted and when it is extended. I have, therefore, little hesitation in assigning this form to Ehrenberg's species, and in this case I substitute for the original specific diagnosis one based upon the specimens I have myself examined, with the fuller details required by the greater knowledge of to-day.

In only one particular is there, I think, a discrepancy. My examples were barely $\frac{1}{100}$ inch, or one-third the length given by Ehrenberg. Inasmuch, however, as all the eight species of Callidina described by him were either $\frac{1}{2}$ or $\frac{1}{3}$ line, it is suggested that he employed at the time no very exact means of measurement, and therefore I attach little importance to the point. The species is of robust habit, slow and deliberate in its movements. The ample discs are separated by a wide sulcus. In direct dorsal view, the upper lip is somewhat concave, without lobes or hillocks, but the edge is usually finely toothed centrally, more coarsely laterally, the teeth appearing to be simply of fleshy character. While feeding the neck is unusually shortened by partial retraction. The skin, always clean, is rough, finely stippled, and rather stiff. A peculiar conformation of the anterior margin of that portion covering the first central segment is very distinctive. When the creature is extended or feeding this margin is seen to

bear four dorsal and two ventral knob-like prominences arranged in two sets of three. On the ventral side the pair there visible are widely separated, the intervening margin of the segment being excised in a moderate curve. When the Callidina is feeding the neck is so withdrawn by retraction that the exterior of the underlip rests upon this excised margin. On the dorsal side the interval between the second and third prominence is greater than that between the first and second or the third and fourth. When the animal contracts itself, and the invertile segments are drawn back within the trunk segments in the usual way, these six prominences become the anterior of the irregularly globose figure which results, and in the process each set of three is so gathered together, while remaining relatively apart from the other set, that the produced anterior extremity of the contracted animal seems to have a median cleft, an appearance I have not observed in any other species.

The transverse skin-folds do not extend quite across the ventral surface. When this is directly visible there are conspicuous at each side two longitudinal folds, properly belonging to the lateral series, and more centrally three very short folds. The central one extends only from near the edge of the first central segment where most excised to the posterior of the same segment, but not reaching the first transverse fold. The pair next to it are but little longer. Starting near the tips of the ventral prominences already mentioned, they extend to the first transverse fold. These three short skin-folds are not included in the stated fourteen dorsal and lateral folds. The next pair are much longer, and proceed from the tips of the prominences to near the rear of the fourth trunk segment, describing each a curve in their course (like the brackets of a parenthesis). The third pair arise from between the ventral prominences and the outer dorsal prominences, and proceed to the rear of the pre-anal segment. In like manner the transverse folds have various lengths and courses. The first and second belong to the second central, the next three to the third, and the following three to the fourth. None of these eight mark the limits of segments, but the ninth and a faintly-marked tenth are plainly the posterior edges of the fourth central and the pre-anal segment. Of the first eight only Nos. 4, 5, and 6 reach the inner longer pair of longitudinal folds. Nos. 7 and 8 turn towards each other, and become continuous. It is usual to refer to that part of the foot which is protruded beyond the spur-bearing segment as consisting of a

single joint. Having regard, however, to the separate movements of the toes and their presumable control by different muscles, I incline to consider that in reality there are two segments present, at all events in those cases where there are either three or four toes. The central single toe (or where there are four the central pair) is protruded and withdrawn independently of the outer pair, and usually distinctly beyond them. The central toe (or pair) is probably, therefore, to be more correctly considered as proceeding from the real terminal, the outer pair of toes from the penultimate, and the spurs from the ante-penultimate foot joint. In the present case the central pair of toes are stouter than the outer pair, and broadly truncate.

Callidina russeola, Zelinka.⁹

Sp. Ch.—Large and bulky. Body stout throughout, not centrally swollen, but somewhat thickened at level of mastax and at pre-anal segment. Yellowish-red to reddish. Corona large, upper lip wide, with slightly convex margin, without lobes or hillocks. Rostral lamellæ stand apart to right and left of rostrum tip. Skin stippled. Antenna short. Mastax with six salivary glands attached. Rami longer than combined width, (31) against (29.4), formula $\frac{5}{8}$ to $\frac{7}{7}$. Vascular canals with eight vibratile tags on each side. Mucus glands of foot built up each of three series of cells. Foot short, of three joints in all, the second bearing the spurs, and the terminal furnished with a perforate disc, of reniform outline on which arise two small prominences. Spurs short (12), perforate at tips, and separated by wide (13), slightly convex interstice. Maximum length ("500" Zelinka, "680" Janson).

In 1892 I found near Felixstowe a large *Callidina*, which I was unable to identify then, but which I am now certain was this species, which had been described in the previous year by Zelinka, who has devoted much time to a searching investigation of every detail of its anatomy and of its embryological development. The most distinctive points in its diagnosis are the form of the upper lip, and the suppression or absence of the toes, these being represented only by the two small prominences on the disc of the terminal joint. In the rami is found a good instance of the variation of the tooth-formula which obtains in many species. The fine striæ which, as usual, cover the

upper surface of the rami, before and behind the ridges known as "teeth," are present also between these.

Whilst conducting his investigations Zelinka kept specimens of this species, and of some other forms, alive in water, in shallow glass vessels, well covered, and provided with algæ, from the beginning of February to the beginning of July, the vessels being daily looked over, all eggs removed, and the number of specimens ascertained, so that young individuals could not unnoticed remain in the vessels. Thus he proved that the one generation of Callidinæ lived for five months, at the end of which period the observations were given over. Such a period of active life, unbroken by any interval of inactivity enforced from lack of water, is, as he remarks, "a much longer span of life than has hitherto been imagined to be possible for these animals."

He was also able to satisfy himself that Plate's ^{6, 7} statements as to the discharge of the vascular canals into the cloaca itself in the cases of *Rotifer vulgaris* and *Call. magna* applied also to *Call. russeola*. The two canals unite into a single duct, which opens into the cloaca at the boundary between it and the intestine. There is no separate contractile vesicle such as is found in all other Rotifera, except the Bdelloida, and such as, until these most recent observations, has been assumed to be possessed also by them. The cloaca itself is distensible and contractile, and fulfils the double function of contractile vesicle and cloaca. This new view is strongly supported by Janson,⁴ who regards the contractile cloaca of the Bdelloida as additional evidence that this group is the primitive group of the Rotifera.

Callidina vorax, Janson.⁴

Sp. Ch.—Body usually very reddish. Corona very ample and flat. Rostral lamellæ somewhat laterally projecting. Spurs $\frac{1}{3}$ width of segment (16·5), with very wide interstice and perforate; four toes; four mucus glands. Rami (23·4-24), with formula $\frac{2}{2}$. Maximum length (440).

A large form somewhat resembling *Call. russeola* in build, but easily distinguished by the form of the corona, the tooth-formula, the foot structure, and the very wide interstice between the spurs. The body is described as consisting of 16 segments, of which seven belong to the head and neck, six to the trunk, and three (in all) to the foot. Thus the head and neck have one more

segment than usual, and the foot one less. The spurs arise at a distance from each other of almost twice their length, and the segment bearing them has dorsally a transverse skin fold, which hides about a third of their length, so that they appear to be only (11) long. They are perforate, and can be moved towards each other like forceps. The four toes of the foot are all short, but the central pair are smaller than the outer. There are four mucus glands, which unite and give off six ducts leading to openings in the two spurs and the four toes. Of vibratile tags six were found on each side. The yolk-mass of the ovary contains eight large round nuclei, and the germ-mass usually four minute nuclei. The short antenna is two-jointed.

I have little to add to these particulars. In one example the corona measured (102), the collar (71), the neck (55). The eggs which, laid by isolated specimens, I could identify as belonging to this species were broadly oval, about (80) long by (63) broad, the surface having slight prominences, and the smaller end being bluntly pointed. The whole egg was of a bright chitinous brown. The embryo was fully developed in about seven days. I have met with the species in wall moss from Clapton and from Bognor, and in ground moss from Arundel.

Callidina Ehrenbergii, Janson.⁴

Sp. Ch.—Body colourless or reddish, with slight thickening below mastax. Rostrum broadly truncate, the sheath drawn out into lateral auricles. Spurs as long (8-10) as width of their segment, with small interstice. Rami (20-22), formula, $\frac{2}{2}$. Maximum length (360).

The body is stated to consist of 11 segments, of which four belong to the head and neck, four to the trunk, and three to the foot. The chief mark of the species is the structure of the rostrum, which is quite similar to that of the *Adinetæ*. At its anterior end the rostral sheath is dorsally bent broadly downwards, and thus, in lateral view, forms a little "hook." The ventral surface of this sheath is very deeply excavate; there only project two corners towards the centre and form with the dorsal arch a pair of lateral auricles. In this sheath thus modified are placed the two small rostral lamellæ, from whose lower surfaces arise the cilia. Frequently several long stiff cilia protrude from the auricles, but from their extreme delicacy are difficult to

define. The corona, very rarely displayed, is exactly equal in width to the neck. When the wheels are at work the rostrum remains extended. There are eight dorsal, but only four ventral skin-folds. The spurs of the very short foot are usually spread out in swallowtail fashion, and are not perforate, nor are they quite constant in shape in different individuals. Each of the three short toes has three perforations for the emission of mucus. Both the yolk-mass and the germ-mass have eight nuclei. The outer margins of the rami are thickened and dark yellow, and have a comb-like edge. The supposed resting egg is described and figured as having a few simple low prominences.

The species is said to be a true moss form, which was only rarely found in open water; its movements are extremely lively and quick. It is with just a little doubt that I assign to it a form of rather frequent occurrence in "dry" moss. The doubt arises partly from my inability to make out so clearly as I could wish the described structure of the rostrum, and partly from the form of the eggs laid by isolated examples. These eggs were covered with blunt spines, and were not resting eggs, but hatched out without any long delay, the embryo moving within 12 days of isolation of parents. In other respects the description fitted fairly well, both as to structure and habits. I thought the upper lip, not mentioned by Janson, was rather distinctive. It is simple in outline, and rises nearly to level of discs, completely hiding the moderate gap between pedicels. The collar width was slightly less than that of the corona.

Callidina fusca, n. sp. (Pl. XXIII., Fig. 2.)

Sp. Ch.—Rather small, but stout. Skin of trunk greyish or reddish-brown, rough and viscid, with coarse, irregular dorsal and lateral longitudinal, and obscure transverse ventral folds; of extremities colourless, clean and fairly smooth. First cervical with three prominent swellings, two lateral, one sub-ventral. Corona (32), just wider than collar, ($28\frac{1}{2}$); sulcus narrow; upper lip, a prominent, undivided lobe. Mastax scutelliform, rami (15), formula, $\frac{5}{5}$ to $\frac{5}{6}$. Foot of four joints, the first with distinct boss. Spurs moderately short (7) and acute. Toes, three. Food moulded into pellets. Maximum length (211).

A robust little form, whose colour, shoulder swellings, pro-

minent rostrum, and coat of dirt recall the like points of *Call. longirostris*, with a suggestion of *Call. aspera*, which in size it more nearly resembles. The skin-folds are not, however, wart-crowned, but have their ridges broken by numerous transverse creases. That the skin is viscid is proved by the coating of foreign matter with which it is liberally covered, but the viscosity is confined to the trunk. The head, neck, and foot are usually clean. Save on the first foot joint, I could see no trace of the minute pores which, according to Janson,⁴ pour forth the viscid secretion in other species. The transverse ventral folds are much less distinct than in *Call. alpium*, but still sufficiently obvious. The corona is rather small, and the discs approach each other very nearly, and have in dorsal view a somewhat square outline.

The first cervical segment has three almost lappet-like swellings of the hypodermic layer, of which two proceed from the base of the antennæ towards the ventral side, attaining greatest size on the dorso-lateral angle, and thus forming thickened and somewhat prominent epaulets, and the third lies across the ventral surface just below the mouth. When the corona is displayed, the sub-ventral process is thrown outwards and backwards, and is distinct, either in direct ventral or in lateral view. The lateral lobes correspond to the fronto-lateral prominences of *Call. longirostris* and some other forms, but I know of no other species having the sub-ventral swelling. I have thought that the function of all three is to protect the more delicate parts of the head when the creature is pushing its way among the sand-grains, which coat even the cleanest specimens of ground and wall moss, and I should accordingly expect that all or most other species with these swellings would be found principally among such mosses. It might be further inferred that the species which have developed these protective swellings are species of longer standing in their chosen habitat than others which have not yet acquired them.

The antenna is rather short, but is stout and tipped with rather long setæ. The foot boss is more prominent and harder-looking than usual, while across the anal segment there is a distinct dorsal ridge, which appears to mark the limit of the non-invertile skin. Specimens were exhibited at the meeting of the Club on 6th October, 1893.

Habitat. Wall moss from South Bersted, near Bognor.

Callidina plena, n. sp. (Pl. XXIV., Fig. 4.)

Sp. Ch.-- Moderately large and robust. Skin smooth, dorsal folds faint, lateral strong. Corona very wide (73), one-half wider than collar (50); upper lip with two low conical lobes, separated by shallow, broadly V-like groove. Rami (19), with thin wing-like outer expansion of rounded outline, giving total breadth (25), the rami proper totalling about (17); formula $2+1, 1+2$. Foot with four joints, in length about (40), or one-eighth of whole; spurs short cones (6) with narrow interstice; toes four. Stomach wall lined with cilia, driving the food in a spiral course. Maximum length (380), average (340).

When crawling about this species resembles very much *Call. musculosa*, but when it pushes forth its corona and begins to feed it assumes somewhat of the compact and apparently stout form of *Call. quadricornifera*. Like that commoner form, however, it is then much flattened, and the apparent bulk is deceptive. It is readily distinguished by the great width of the corona as compared with the collar and with the body length, a strong character well supported by the modelling of the upper lip, the feeding position, the small spurs, and the four toes. The planes of the two discs do not coincide, but incline somewhat obviously to the median line. The upper lip is so prominent that the conical lobes attain the level of the discs at their inner side. Thus the whole breadth is approximately flat.

The three cervical segments are all short, especially the first and second, whilst the second, third, and fourth central are rather longer than usual. In the feeding position the whole of the second cervical and part of the first is hidden within the third, and of the foot only the spurs and part of the first joint are visible. The first foot joint is of fair length, but the second is short, and the third almost indistinguishable. The four toes are, as usual, in two pairs, of which the outer pair are larger than the inner. One tooth on each ramus is exceedingly faint.

I have found this species in great numbers in wall moss from Aldwick, near Bognor, and I was able also to identify certain eggs as pertaining to it. These were not truly oval, but a little flattened, and the surface bore many low rounded prominences, of which I counted 14 to 18 around the peripheral outline. As they lay on their sides these eggs measured (76 to 85) longest by (50 to 54) shortest diameter, and I estimated their thickness at about

(38). In one case the embryo hatched out in about seven days. In a crushed specimen I was able to count twelve minute nuclei in the germ-mass.

Callidina habita, n. sp. (Pl. XXIV., Fig. 5.)

Sp. Ch.—Moderately large and stout. Skin smooth, very finely stippled, with faint dorsal and strong lateral folds. Corona rather wide (64), about one-fourth wider than collar (51); upper lip rather prominent, with two lobes separated by narrow notch. Rami (24), with thin wing-like outer extension, of rounded outline; formula $2+1, 1+2$. Foot of three joints, short, stout; spurs very short, with very broad bases; toes three, very short. Maximum length (570), average (400).

In company with *C. plena* were a few specimens of this form, which presented an almost similar appearance when travelling about, but always distinguishable by the spurs and by a greater stoutness of the body, especially in the pre-anal and anal segments and the foot. Yet when displayed the corona was found to be decidedly narrower, the difference arising partly from a lesser distance between the discs. The rami having the same formula were decidedly longer, and the wing-like margin was narrower. I could not detect more than three toes on the terminal foot joint, one being (if fully protruded) very thick and abruptly truncate. The first foot joint bears a small but distinct dorsal boss, and the next joint, which carries the spurs, has a stout fold of skin projecting over them. The spurs are extremely short cones with unusually broad and thick bases; the points suddenly attenuate and a little produced. As in *C. plena* the outer edge is nearly straight, but the inner edges, nearly in contact at the base, are first boldly convex and then apparently slightly concave near the tip. Their extremities stand apart about (22 to 24), the corresponding figure in *plena* being (15 to 17).

I have also found the species in moss from a thatched roof at Deal, and in ground moss from just above tide mark at Bognor.

Callidina angusta, n. sp. (Pl. XXIV., Fig. 6.)

Sp. Ch.—Of moderate size and rather slender; corona narrow (29), about equal to collar, but apparently less. The lateral margins of the mouth have externally a prominent, almost pointed, swelling. The discs, rather square in outline, are separated by a

narrow cleft. Antenna short. Rami, formula $\frac{2}{2}$. Length when feeding (275).

My particulars of this species, of which I found a single example on two different occasions in ground moss collected near Bognor, are less complete than I could have wished. When feeding it extends itself to its utmost (a rather unusual habit among Callidinæ), displaying a slender head, neck, and trunk, and a rather short foot, with stout but short spurs. At the collar level, but really arising from the lateral margins of the mouth, there is on each side a rather prominent and almost pointed swelling, best seen in ventral aspect, and giving, at first glance, the appearance of a wider collar than is actually present. That the mouth border should be thickened at the sides is usual among the Philodinadæ, but it is unusual that this thickening should result in or be supplemented by external and prominent swellings. This curious character is also present in the species next to be described, but in that case it can scarcely be seen except when looking directly upon the mouth from above.

The outstretched attitude, the generally slender body, the peculiarities of the corona and of the mouth border sufficiently, at all events as yet, distinguish the species, which seems uncommon.

Callidina eremita, n. sp. (Pl. XXIII., Fig. 3.)

Sp. Ch.—Small, with slender head and neck, and swollen central trunk. Skin smooth, with strong lateral folds. Corona, moderately spreading, (38); discs on high diverging pedicels, separated by a deep U-shaped sulcus, in which is conspicuous a small setiform fleshy tooth, (5) long and (1) diam. Upper lip remote from pedicels, of simple, bold, curved outline, lateral mouth margins externally swollen. Collar (28); neck (25), of long narrow segments, and with a distinct annular thickening at level of antenna. Mastax rather scutelliform; rami (17); formula, $\frac{3}{3}$ to $\frac{3}{4}$. Foot extremely short, only visible when animal dislodged and crawling. Spurs, very minute cones or absent. Food moulded into pellets. Secretes a flask-shaped case, at first colourless, but gradually becoming brown.

An extremely interesting species, with many distinctive marks. In preceding papers I have recorded the tube-dwelling habits of *Call. elegans*, Milne, and *Call. pusilla*. In both instances the tubes appeared externally to be a more or less rough

agglomeration of drift particles, in which one failed to detect the presence of any secretion from the tenant. The tube made by *Call. eremita* is undeniably mainly composed of a secretion, for if forced by circumstances to abandon its tube or case the Callidina will, in the live box and in the course of a few days, develop around it a delicate investment, which is gradually increased in density until it is recognizable as a perfect case. The form is that of a somewhat flattened flask, which is attached to the moss leaf or stem by that side which protects the ventrum. The neck of the flask fits somewhat tightly to the first central when the animal is extended or feeding, and is there somewhat viscid, as is evidenced by a cloud-like mass of drift particles adhering to it. It also adheres to the skin, so that when the animal withdraws from view the anterior edges of the case are drawn inwards and the opening closed. The case is usually only just large enough to contain the Rotifer when retracted; sometimes, however, an egg could also be seen in the cavity. I could detect no trace of structure, but noticed only a somewhat plentiful sprinkling of minute and more solid-looking points. I conjecture, however, that the material employed would probably be identical with that employed by the Callidinæ generally for the "varnishing" of their trunks when they fear deprivation of water. I believe, too, that it is mainly secreted while the animal is retracted, a position which my specimens would retain frequently for hours. When desired it was usually easy, however, to induce them to display their wheels; the introduction into the live box of a drop of clear cold water was very effective. Then instinct prevailed over modesty, and out would come the Callidina to sample the current food supply. The head and neck once protruded, usually at right angles to the trunk, the discs were promptly displayed and the cilia vigorously exerted. The high diverging pedicels give a very distinctive character to the corona, and equally striking is the bold curvature of the upper lip, which is apparently nowhere in contact with the pedicels, but stands back so that their common fleshy base is visible. Centrally between the pedicels stands a short setiform fleshy tooth. Thus outstretched the head and neck are nearly as long as the trunk, and the bizarre appearance of the swollen central trunk is increased by the first central segment which occupies the neck of the flask being slender like the head and neck. The mastax is of good size. Besides the three

well-marked teeth on each ramus (slightly diverging towards the inner edge), a faint fourth could sometimes be detected. The lateral skin-folds were rather conspicuous on the trunk. The rostrum is stout but very short.

It was difficult to make out anything about the internal organs, but in many instances the stomach contained pellets of food. A young specimen seen crawling about was in build rather like others of the small and slender species, but older individuals are very loth to move about, and the trunk becomes swollen, and the foot almost permanently hidden. I thought, in dislodged examples, that I could distinguish two very minute peg-like spurs placed far apart at the lateral angles of a stout joint, but I failed, after repeated efforts, to force their display, far less that of the toes.

It seems obvious that this *Callidina* has acquired its long neck, its swollen trunk, and its short and constantly hidden foot after becoming a tube-dweller. In these points of habit and of build it recalls *Call. reclusa*, which dwells in the cortical cells of the branches of *Sphagnum*, and which has to push its head and neck through a small natural opening in the cell wall.

The species was found in wall mosses from various localities near Bognor, but from its retiring habits is not easy to detect.

Reference is made by small numbers after names of authors to the following works :—

1. *Ehrenberg*.—Fortgesetzte Beobachtungen über atmosphärische mikroskopische Organismen. *Novarum specierum diagnosis*. Monatsberichte der Berliner Akad. der Wiss., p. 380, 1848.

2. *Ehrenberg*.—Über neue Anschauungen des Kleinsten nördlichen Polarlebens. Monatsberichte der Berl. Akad. der Wiss., p. 529, 1853.

3. *C. T. Hudson* and *P. H. Gosse*.—The Rotifera or Wheel-animalcules, London, 1886, and Supplement, 1889.

4. *O. Janson*.—Versuch einer Übersicht über die Rotatorien-Familie der Philodinæen. Beilage zum xii. Bande der Abhandl. des Naturw. Vereins zu Bremen, 1893.

5. *W. Milne*.—On the defectiveness of the Eyespot as a means of Generic Distinction in the Philodinæa. Proc. Phil. Soc., Glasgow, 1886.

6. *L. Plate*.—Beiträge zur Naturgeschichte der Rotatorien. Jen. Zeitschr. für Naturwiss., Vol. xix., Part i., 1885.

7. *L. Plate*.—Über die Rotatorienfauna des Bottnischen Meerbusens. Zeitsch. für Wiss. Zool., Vol. xlix., 1889.

8. *P. G. Thompson*.—Moss-haunting Rotifers. Science Gossip, Vol. xxviii., p. 56, 1892.

9. *Carl Zelinka*.—Studien über Raderthiere, iii., Zur Entwicklungsgeschichte der Räderthiere nebst Bemerkungen über ihre Anatomie und Biologie. Zeits. für Wiss. Zool., Vol. liii., 1891.

EXPLANATION OF PLATES.

PLATE XXIII.

FIG. 1. *Callidina alpium*, dorsal. $\times 480$.

„ 2. *Callidina fusca*, ventral. $\times 480$.

2a. Head and neck, lateral.

2b. Foot, dorsal.

2c. Foot, lateral.

2d. Mastax. $\times 800$.

„ 3. *Callidina eremita*, dorsal. $\times 640$.

3a. Rami under pressure, the normally inrolled edges forced back. $\times 800$.

PLATE XXIV.

FIG. 4. *Callidina plena*, dorsal. $\times 400$.

4a. Rostrum and head extended, ventral. $\times 800$.

„ 5. *Callidina habita*, dorsal. $\times 400$.

5a. Rami under pressure, the normally inrolled edges forced back. $\times 800$.

„ 6. *Callidina angusta*, ventral. $\times 480$.